RÜ 12

Dienstag, 12. Juli 2011
16:01

1.3 F 2011(?)

1.1) $$\underline{\underline{S}}_T^T = \begin{pmatrix} S_{11} & S_{21} & S_{31} \\ S_{12} & S_{22} & S_{32} \\ S_{13} & S_{23} & S_{33} \end{pmatrix}^T = \begin{pmatrix} 0 & S_{12} & S_{13} \\ S_{12} & S_{22} & S_{27} \\ S_{13} & S_{23} & S_{33} \end{pmatrix}^T$$

Reziprozität $S_{12} = S_{21}$

$S_{13} = S_{31}$

$S_{23} = S_{32}$ $\qquad S_{11} = 0$

1.2) Symmetrie: $S_{13} = S_{12}$

$S_{22} = S_{33}$

$$\underline{\underline{S}}_T = \begin{pmatrix} 0 & S_{12} & S_{12} \\ S_{12} & S_{22} & S_{23} \\ S_{12} & S_{23} & S_{22} \end{pmatrix}$$

$\Rightarrow$ noch 3 Parameter unbestimmt

1.3) Verlustlos: $\underline{\underline{S}}_T \cdot \underline{\underline{S}}_T^T = E = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

① $|S_{12}|^2 + |S_{12}|^2 = 1$

3.1c) S_{12} positiv und Reell

$\Rightarrow S_{12} = \frac{1}{\sqrt{2}}$

② $S_{12} S_{22}^* + S_{12} S_{23}^* = 0$

$\Rightarrow S_{12}(S_{22}^* + S_{23}^*) = 0$

$S_{22}^* = -S_{23}^*$

3.1b) S_{22} positiv und reell

$\Rightarrow S_{22} = -S_{23}$

(3) $\underbrace{S_{12}\cdot S_{12}^*}_{=|S_{12}|^2} + S_{22}\cdot S_{23}^* + S_{23}\cdot S_{22}^* = 0$

$\Rightarrow S_{22}(S_{23}^* + S_{23}) = -|S_{12}|^2$

(2) in (3) und S_{22} ist positiv und reell

$\Rightarrow S_{22}(-2\cdot S_{22}) = -|S_{12}|^2$

$\Rightarrow S_{22} = +\sqrt{\frac{|S_{12}|^2}{2}} = +\frac{1}{2}$

mit (2) $S_{23} = -S_{22} = -\frac{1}{2}$

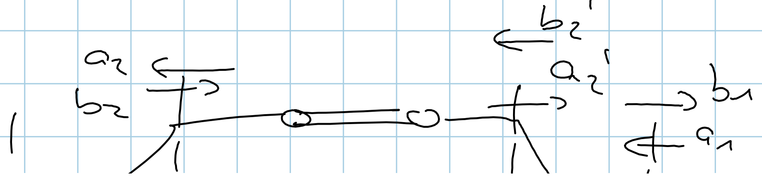
2.1 – Verlustlos

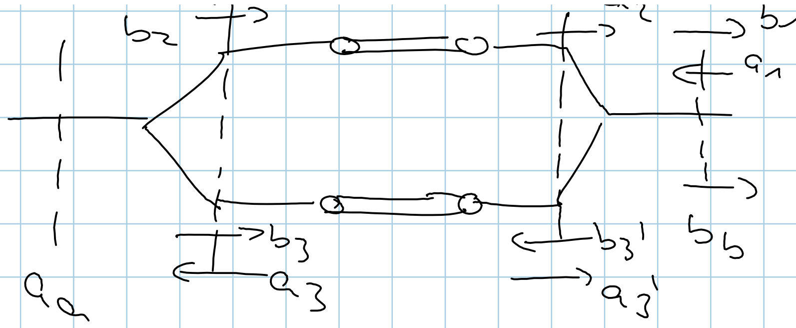
– überall angepasst

$\Rightarrow S_{11} = S_{22} = 0$

$\underline{\underline{S}}_{Li} = \begin{pmatrix} 0 & e^{-j\beta_2 L} \\ e^{-j\beta_1 L} & 0 \end{pmatrix}$ für $i = 1,2$

2.2) für $v_1 = v_2 = 0$ wird $\beta_1 = \beta_2 = 2\frac{\omega}{c_0}$





$$b_B = S_{11}\, a_1 + S_{12}'\, a_2' + S_{13}'\, a_3'$$

$$a_2' = a_3' = S_{22}' \cdot S_{2A} \cdot a_A = \frac{1}{\sqrt{2}}\, a_A$$

$$S_{12}' = S_{13}' = \frac{1}{\sqrt{2}}$$

$$\Rightarrow b_B = \frac{1}{2} \cdot 2 \cdot a_A = a_A$$

<u>2.3)</u> $a_2' = e^{-j\beta_1 L} \cdot b_2$

$$a_3' = e^{-j\beta_2 L} \cdot b_3$$

$$b_B = S_{12}' \cdot a_2' + S_{13}' a_3' = \frac{1}{\sqrt{2}} (a_2' + a_3') \overset{!}{=} 0$$

$$\Rightarrow a_2' = -a_3' \quad (*) \qquad |b_2| = |b_3| \quad (**)$$

Wegen $b_B = 0$ und Verlustlos

muss $|b_A| = a_A$ sein

$$b_A = \frac{1}{\sqrt{2}} (a_2 + a_3) = \frac{1}{\sqrt{2}} \left(e^{-j\beta_1 L} b_2' + e^{-j\beta_2 L} b_3' \right)$$

mit
$$\left.\begin{aligned} b_2' &= \frac{1}{\sqrt{2}} a_B - \frac{1}{2} a_3' + \frac{1}{2} a_2' \\ b_3' &= \frac{1}{\sqrt{2}} a_B - \frac{1}{2} a_3' - \frac{1}{2} a_2' \end{aligned}\right\} \text{mit } a_B = 0$$

$$b_A = \frac{1}{\sqrt{2}} \cdot \frac{1}{2} \left[e^{-j\beta_1 L} (a_1' - a_3') + \right.$$

$$e^{-j\beta_2 L}\,(a_3' - a_2')\,]]$$

$$= \frac{1}{\sqrt{2}}\underbrace{\frac{1}{2}\cdot(a_2' - a_3')}_{=a_2'\ \text{(*)}}(e^{-j\beta_1 L} - e^{-j\beta_2 L})$$

$$= \frac{1}{\sqrt{2}}\, e^{-j\beta_1 L}\, b_2\, (e^{-j\beta_1 L} - e^{-j\beta_2 L})$$

mit $b_2 = a_1 \frac{1}{\sqrt{2}} + \frac{1}{2}(a_2 - a_3)$

$b_3 = a_1 \frac{1}{\sqrt{2}} + \frac{1}{2}(a_3 - a_2)$

Wegen (**) für alle a_1 folgt:

$$a_2 = a_3$$

$$\Rightarrow b_2 = b_3 = \frac{1}{\sqrt{2}}\, a_1$$

$$\Rightarrow b_1 = \frac{1}{2}\, e^{-j\beta_1 L}\, a_1\, (e^{-j\beta_1 L} - e^{-j\beta_2 L})$$

da $|b_1| = a_1$ muss gelten

$$|e^{-j\beta_1 L} - e^{-j\beta_2 L}| = |e^{-j\beta_1 L}|\,|1 - e^{-j(\beta_1-\beta_2)L}|$$

$$= 2$$

somit $L = \dfrac{(2n-1)\pi}{(\beta_2 - \beta_1)}$

kleinste Länge: $L = \dfrac{\pi c_0}{2\pi f} \cdot \dfrac{10^{5r}}{|\nu_2 - \nu_1|} = 1{,}5\,cm$

2.4 AM-Modulator

3.1 $t_{0,opt} = \sqrt{4L\,\frac{|D|}{4\ln}}$

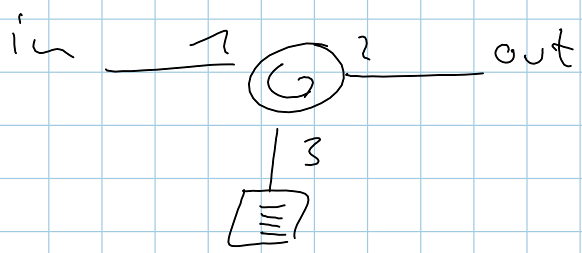
$$|W| = \frac{t_{0,opt}^2 \, \omega c_0}{4L}$$

3.2

a) Dispersionskomp. Faser mit

$$L_{Faser\,2} = \frac{-L_1 D}{D_{Faser\,2}}$$

b) Chirp-Fasergitter

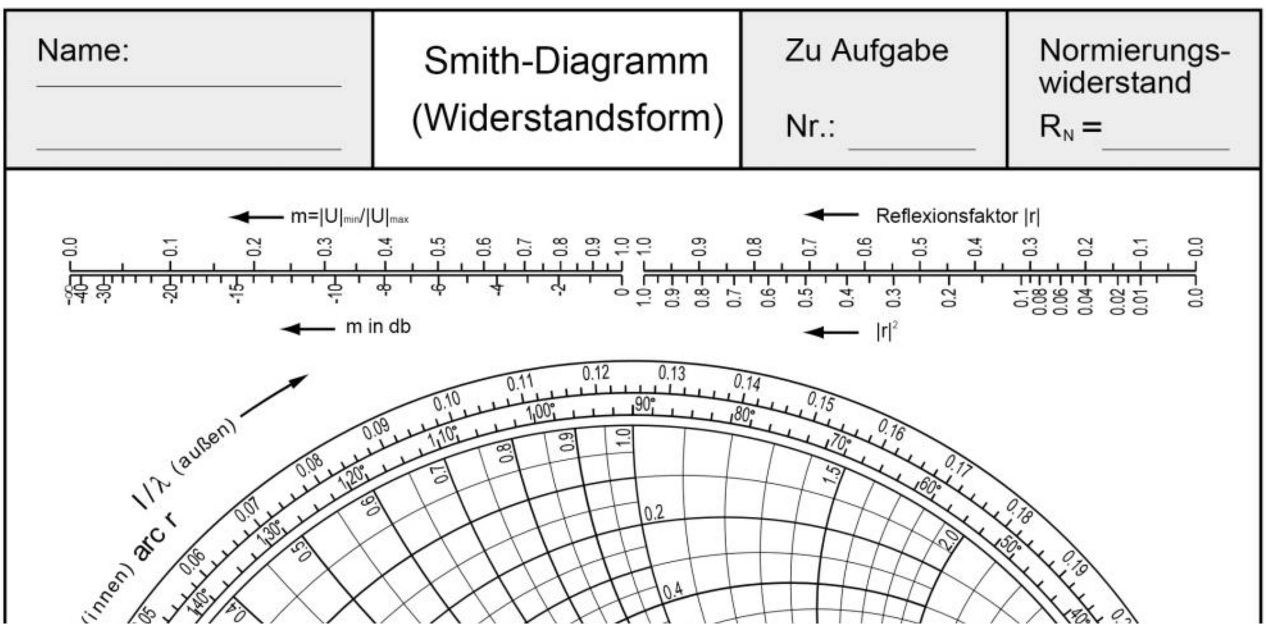


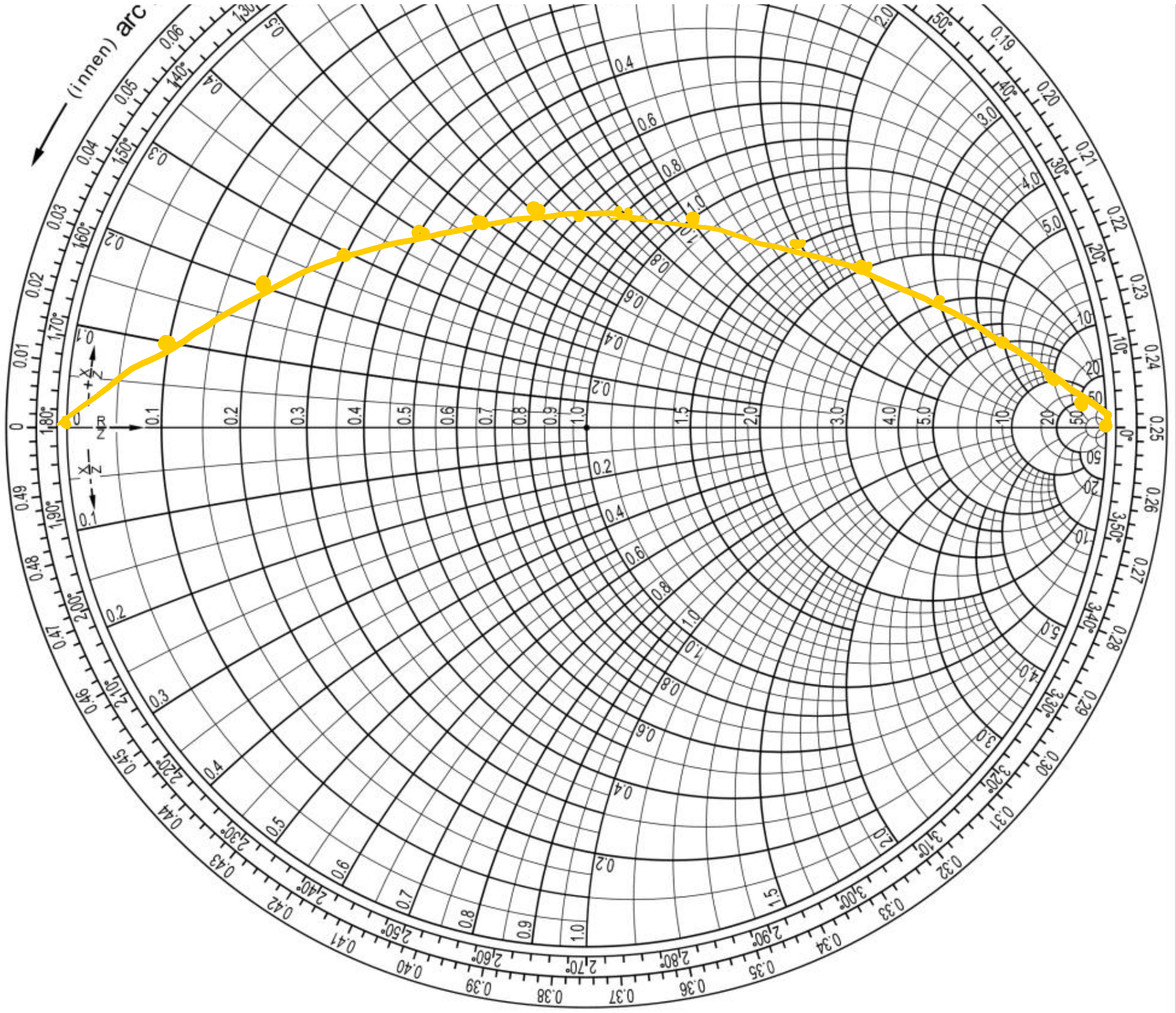
Aufgabe 1

SmithChartNeu

Eingefügt aus: <file://D:\Uni\SmithChartNeu.pdf>

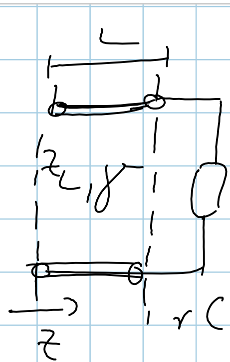
1.1.1





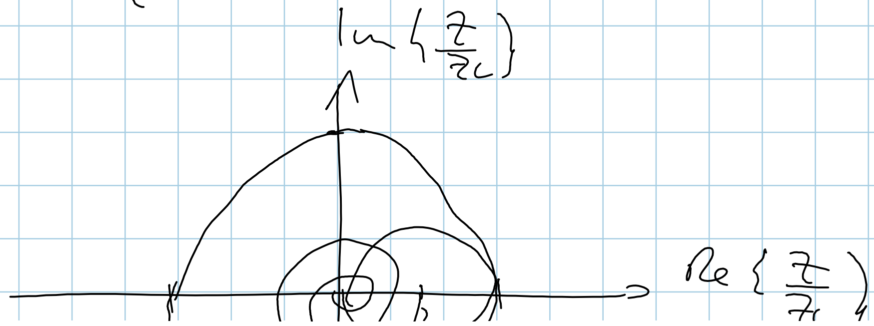
Erläuterungen zum Transformationsweg:

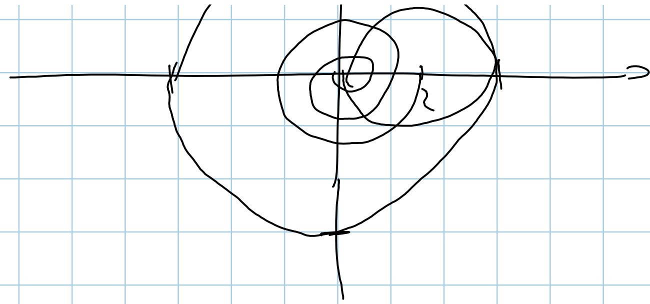
1.1.2)



$R = 2 Z_L$

$$r(z) = r(z=L)\, e^{2\gamma(L-z)}$$





$$r(z) = r(z=L)\, e^{2\gamma(L-z)}$$

$$r(z)\Big|_{z=L} = \frac{1}{3}$$

<u>1.2)</u>

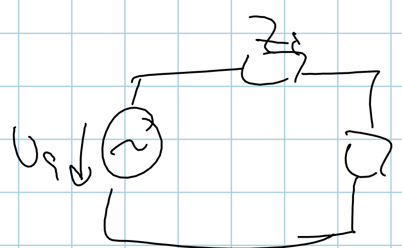
$$\beta = \frac{2\omega}{c_0} \qquad \text{Verlustlos}$$

$$Z_i = \left[1 + j\,\frac{(f-f_2)}{f_1}\right] \cdot 50\,\Omega$$

<u>1.2.1)</u> $$P_{verl\,f_1} = \frac{|U_{q1}|^2}{8 \cdot Re\{Z_i\}} = \frac{(20)^2}{8 \cdot (50)} = 1\,W$$

$$P_{verl\,f_2} = \frac{|U_{q2}|^2}{8\,Re\{Z_i\}} = \frac{(20)^2}{400} = 0{,}25\,W$$

<u>1.2.2)</u>



$$Z_E \overset{!}{=} Z_i^* \quad \text{mit} \quad Z_i\Big|_{f=f_1} = (1-j)\,50\,\Omega$$

$$Z_E = Z_i^* = (1+j)\;50\,\Omega$$

$$U_E = \frac{Z_i^*}{Z_i^* + Z_i} \cdot U_{q1} = \frac{(1+j)\,50\,\Omega}{100} \cdot U_{q1}$$

$$= (1+j)\cdot 10 = 2q \cdot e^{j\,45^\circ}\,V$$

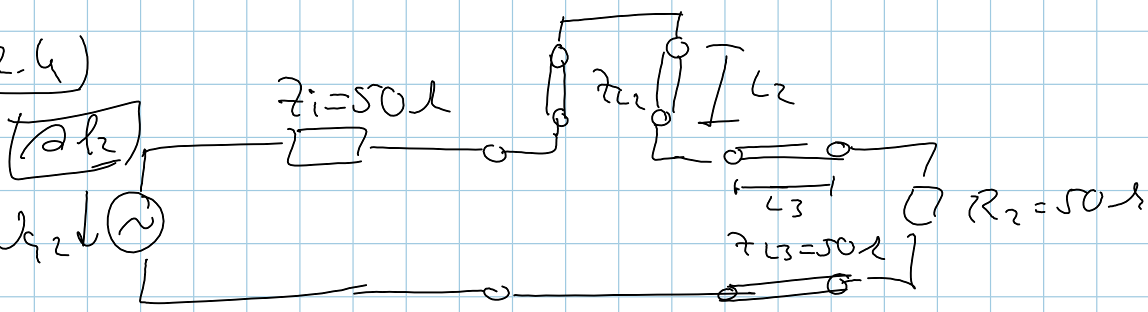
1.2.3)

$$\boxed{\beta = \frac{2\omega}{c_0} \qquad \lambda = \frac{2\pi}{\beta} = \frac{c_0}{2f}}$$

$$L_1 = \frac{\lambda_2}{2} = \frac{c_0}{2 f_2 \cdot 2} = 7{,}5\,\text{cm}$$

$$L_2 = \frac{\lambda_1}{4} = \frac{c_0}{4 f_1 \cdot 2} = 7{,}5\,\text{cm}$$

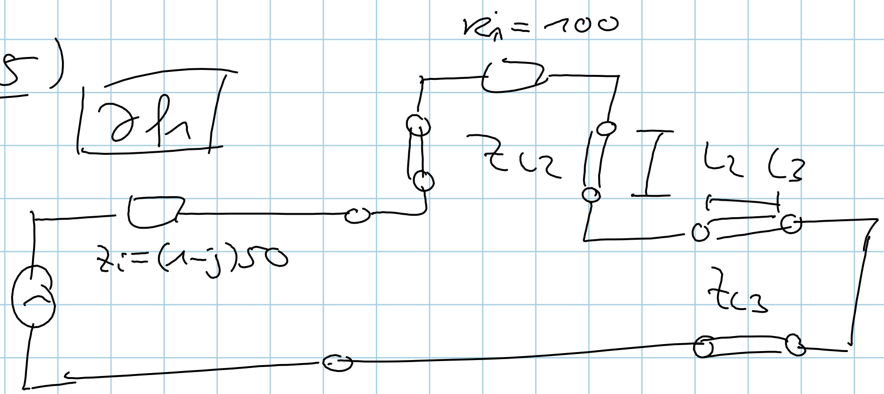
1.2.4)



wegen $Z_{L3} = R_2 = 50$

muss $L_2 = \frac{\lambda_2}{2} = 7{,}5\,\text{cm}$

1.2.5)



wegen $L_2 = \frac{\lambda_1}{4}$ wird die Eingangsimpedanz am Anfang von Leitung 2 reell sein

Somit muss der Imaginärteil von Z_i durch Leitung 3 kompensiert werden

$$j Z_{L3} \tan(\beta L_3) \overset{!}{=} j 50\,\Omega$$

$$\Rightarrow L_3 = \frac{\lambda_1}{8} = 3{,}75\,\text{cm}$$

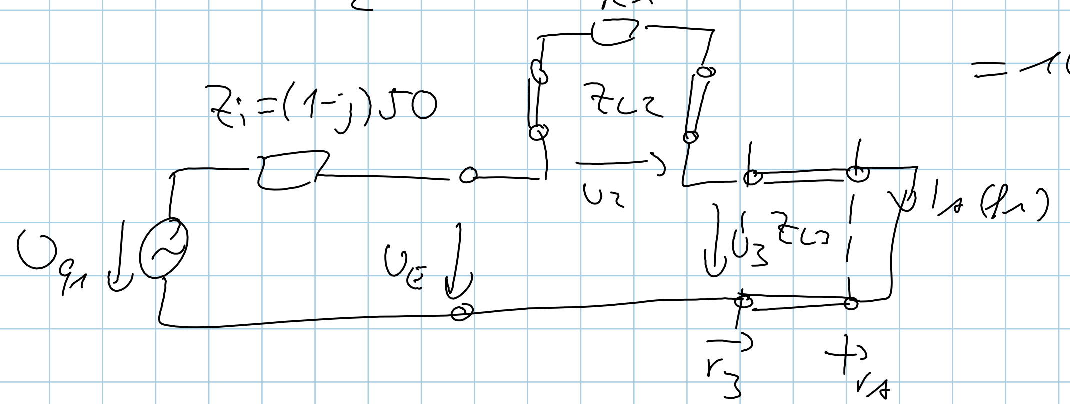
Realteil von Z_i muss Eingangsimpedanz der Leitung 2 entsprechen

$$50\Omega = \frac{Z_{L2}^2}{R_i} \Rightarrow Z_L \approx 70{,}7\,\Omega$$

1.2.6

$$\frac{|I_A(l_2)|^2}{2}\cdot R_2 \overset{!}{=} P_{verl_2} \Rightarrow |I_A(l_2)| = \sqrt{\frac{2\cdot P_{verl_2}}{R_2}}$$

$$= 100\,mA$$



$$U_E = U_2 + U_3 = \frac{(1+j)50}{(1+j)5+(1-j50)}\cdot U_{q1} = (1+j)10\,V$$

mit $U_2 = 10V$

$U_3 = j10V$

$$U_3 = U_{3p} + U_{r3} = (1+r_3)\cdot U_{3p} \quad\Big|\quad \frac{U_{3p}}{I_{3p}} = Z_{L3}$$

$$I_3 = I_{3p} + I_{r3} = (1-r_3)\, I_{3p} \quad\Big|\quad r_3 = -j r_A = j$$

$$I_{3p} = \frac{U_{3p}}{Z_{L3}} = \frac{U_3}{Z_{L3}(1+r_3)}$$

$$I_A = I_{Ap} + I_{Ar} = I_{Ap}(1-r_A)$$

$$= 2\cdot I_{Ap} = 2\cdot e^{-j\beta l_3}\cdot I_{3p}$$

$$= 2\, e^{-j\beta l_3} \quad U_3$$

$$\overline{}$$
$$Z_{L3}(1, r_3)$$

$$\Rightarrow |I_A| = 2\,(141{,}4) = 282{,}8\,\mathrm{mA}$$